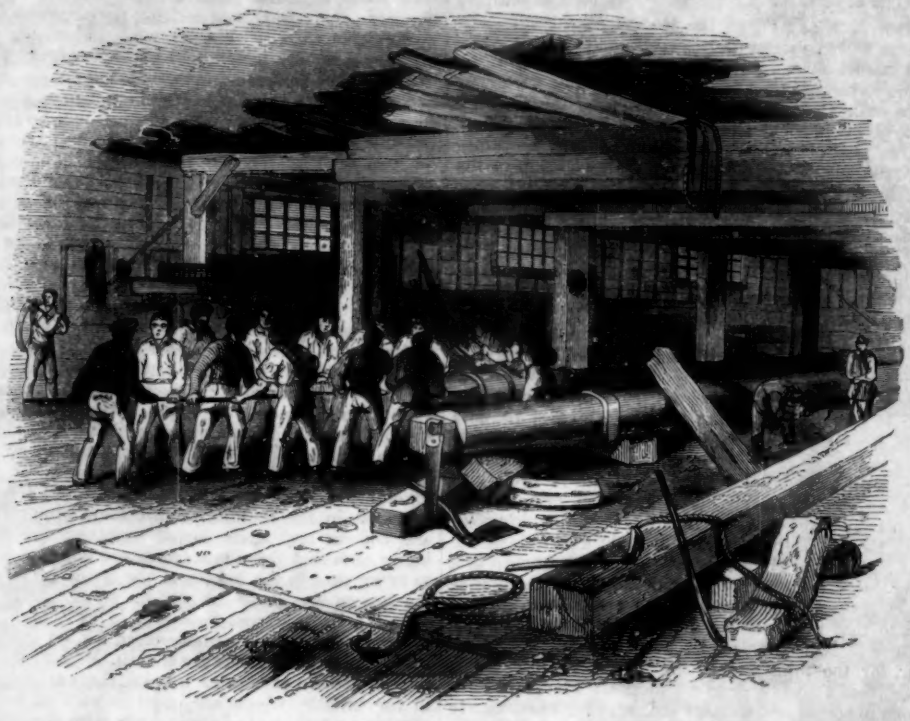
A SECOND DAY AT A SHIP-YARD.



[Interior of Mast-house.]

IN our last Supplement we gave a brief description of the ship-building establishment of Messrs. Green, Wigrams, and Greens at Blackwall, and also traced the earlier part of the processes connected with the construction of a ship. We now propose to take up the subject at the point where we then left it, and to show, as far as the nature of our work admits, the subsequent labours required for the completion of a vessel.

It will be remembered that, after speaking of the occupation of the ship's draughtsman, we explained the arrangement of the building-slip, the laying-down of the keel on the blocks, and the erection of the curved frame-timbers of a vessel. The form of the hull is thus given; in a rude manner, it is true, but still with a degree of certainty which determines the character of the vessel. The numerous pieces subsequently added, whether of British or African oak, elm, or fir, are sawn at the pits, under the supervision of the 'converter;' and are afterwards, in most cases, trimmed, or, as it is termed, 'dubbed,' with an adze. In common carpenter's work, the only tool used, after the saw, for paring away and levelling the surface of wood, is generally the *plane*; but in the work of the shipwright, where more bulky materials are operated on, where almost every piece is to be hollowed or rounded in some part or other, and where great neatness is not required, the adze becomes a valuable instrument. The various kinds of joints whereby one timber or plank is connected with another, such as tenon-and-mortice, &c., are made by the aid of nearly the same tools as those employed in carpentry, but of a larger size and stronger make. As may be reasonably supposed, these prepared timbers are often very bulky and ponderous; and the conveyance of them from the saw-pit to the building-slip requires the aid of horses. There is a whimsical anecdote given by Strype, in his edition of Stow's 'Survey of London,' which, while it immediately illustrates this subject, also carries us back to an early period in the history of the Blackwall ship-yard, introducing us to this scene of bustle as it was in the seventeenth century:—"In the time of the elder Sir Henry Johnson, Knt., ship-builder, an horse belonging to his yard was wrought there thirty-four years, driven by one man; and he grew to that experience, that at the first sound of the bell for the men in the yard to leave off work, he also would cease labouring, and could not by any means be brought to give one pull after it: and when the bell rang to work, he would as readily come forth again to his labour, which was to draw planks and pieces of timber from one part of the yard to another." We believe that a public-house in Blackwall has received the sign of the 'Old Hob,' in honour of the horse which bore that name, and which took this very independent mode of showing his importance.

But to return. The keel, the stern-post, and the stem, form the three great supports of the frame of the vessel; the first being horizontal, the second rising from it almost perpendicularly at one end, and the third rising in a curve at the other. Among the timbers which are subsequently adjusted to the vessel are

three, called the keelson, the sternson, and the stemson, which are in some sense interior representatives of the three just named. The keelson is fixed on the floor timbers, immediately over the keel, and forms that part on which the steps or blocks of wood are placed which support the masts: it is secured down to the keel by means of bolts three feet in length, which pass entirely through both, as well as the intervening wood. The stemson and the sternson rise from the two ends of the keelson, and form internal supports to the ends of the vessel. The timbers are often strengthened within by pieces called *riders;* but in modern vessels they are frequently secured and braced one to another by diagonal iron plates, from half an inch to an inch in thickness, passing nearly from the top to the bottom of the hull, inside the vessel. Being bent round the concavity of the ship's side in an oblique direction, each piece of iron crosses several different frames of timbers, and is securely bolted to them all.

The small portion of the hull of a vessel which is seen above the level of the water presents to view a surface covered with horizontal or nearly horizontal ranges of planking; and if we could see lower down, towards the keel, we should find a similar approach to a horizontal direction in the pieces of wood with which the hull is covered. Withinside, too, a similar arrangement is observable. The vertical frames of timbers of which we have been speaking do not present themselves to the eye of a person viewing a finished vessel, either within or without. The whole are covered with planking, laid in nearly horizontal rows or 'strakes.' The planks may be regarded as forming the skin with which the ribs of the ship are covered; and, indeed, the shipwrights, who almost seem to regard their ship as a living being, apply the term 'skinning' to the operation of laying on these planks; an opposite sense, it is true, to that in which we are in the habit of using this term. Nor is this skin by any means a trifling affair, for the thickness of the planks which form it varies from about three to six inches. The planks are formed of sound and durable oak, and are often nearly thirty feet in length. They are brought, while at the saw-pit, as nearly to the required form as may be practicable; and are afterwards worked with the adze, to give them the proper contour. This must not be supposed to imply that the planks are hollowed or curved by the adze to the exact shape of the vessel, but that the width and thickness of adjoining planks are adjusted to each other. When a prepared plank is laid against the outside of a vessel, the convexity of the latter causes the ends of the planks to stand out several inches from it; and on the other hand, when laid on the inside, the concave surface causes the ends to be in contact with the timbers, and the middle to be several inches away from them. The planks require, therefore, the aid of powerful instruments to force them close to the timbers previous to bolting, and this operation is further assisted by bringing the plank to a heated and moistened state by steam.

The parts of the planking vary in thickness, and receive distinctive names, according to the places which they occupy; but all are treated nearly in the same way—sawn, dressed with an adze, steamed, forced to the curvature of the ship, and fastened to the timbers with bolts. The trenails, which are more numerous than the bolts, are not driven in till a subsequent stage in the operations. In adjusting the planks to the ship's sides, care is always taken that the adjoining ends of two planks in one row or strake shall not occur at the same part of the ship's length as a joint in the row next above or below it, a caution similar to that observed in laying the courses of bricks in a wall, or the rows of slates on a roof, and the object of which is sufficiently obvious in relation to the strength of the structure. Whoever has an opportunity of seeing the whole hull of a vessel, will observe that the planking is ranged with great regularity, each strake or row diminishing in width towards the ends, to conform with the diminishing size of the vessel.

In the building of a ship matters are so arranged that many different parts are in progress simultaneously; some workmen making preparations for the beams of a vessel withinside, while others are planking the exterior, and others perhaps engaged at various parts of the head and stern. The beams are stout and well finished timbers stretching across the vessel from side to side, at intervals of a few feet, and serving not only to support the deck or decks, but also to bind the two sides of the vessel together. These beams, situated as they are at right angles to the keel, have given rise to many nautical expressions which are rather incomprehensible to general readers: thus the 'breadth of beam' is the width of a vessel; an object seen at sea in a direction at right angles with the keel, is said to be 'on the beam;' when a ship inclines very much on one side, so that her beams approach to a vertical position, she is said to be 'on her beam ends;' and many other similar phrases might be adduced.

The beams are ranged at such distances apart, that an East Indiaman of a thousand tons burden requires about thirty beneath the main deck. Each beam is usually formed either of one or of three pieces, according to the dimensions of the vessel; the three pieces, in the latter case, being securely joined or scarfed together. The beams are not straight, but are curved upwards in the middle, so that their upper surfaces are convex and their lower concave; the bending being such that there is a curvature of about one inch to every yard in the length of the beam. The ends of the beams are made to rest on stout planks called clamps; but the real fastening is by means of iron brackets technically termed *knees*, bolted both to the beam and to the timbers of the ship. Besides the fastenings at the two ends of each beam, there are supporters in the middle, which are often formed of cast-iron, combining lightness of appearance with strength.

Various ledges and frames, called *partners*, *coamings*, and *carlings*, being arranged between the beams, the decks are next attended to. These divide the hull into different stories, analogous to those of a house; and in the one case as in the other, the number of floors is greater in some instances than in others. Large ships of war are furnished with three entire decks, reaching from the stem to the stern; besides two shorter decks called the forecastle and the quarter-deck, the one placed at the head of the vessel, and the other towards the stern, a vacant space called the *waist* being left between them, at the middle of the ship's length. In smaller vessels of war, and in merchantmen, the decks are fewer; two whole decks and a quarter-deck being the number in an East Indiaman. The deck is generally made of Dantzig or Memel fir, and for vessels exposed to a hot climate yellow pine is sometimes employed. The deck-planks are laid side by side, lengthwise of the ship, or parallel to the keel, and vary from six to ten inches in breadth, and from two to four in thickness. They are nailed down to every beam and to every carling, either with iron nails or with nails formed of a mixed metal.

We have said that the planking which covers the inside and outside of a ship is secured, partly by bolts and partly by wooden pins called trenails, to the timbers; and that the trenails are not driven in until some time after the bolts. The object of this seems to be, that by making the trenail-holes a considerable time before the trenails are inserted, the wood round each hole has an opportunity to become seasoned. The holes are made with an auger, which is a kind of gim-

blet or borer, varying from an inch to two inches in diameter, according to the size of the trenail to be inserted. The head of the auger is provided with a cross handle of considerable length, which furnishes a leverage to the workman using the instrument. This kind of labour is often very severe, from the hardness of the wood, the great depth to which the hole is to be bored, and the awkward position in which the man has to place himself. The curvature of a ship near the keel is almost horizontal, and at other parts goes through all the gradations from a horizontal to a ver-

tical direction; and the man who is engaged in boring the trenail-holes has to vary his position and mode of working, sometimes standing and at other times sitting, according to the part of the vessel at which he is at work. It is so arranged that the same trenail shall pass, not only through the outer planking and the frame-timber, but also through the inner planking; by which all three are bound well together; and the trenail-holes are bored in conformity with this arrangement. When the proper time arrives for driving in the trenails, a set of men, each provided with a large and heavy hammer, proceed to that operation. The trenail is made slightly larger than the hole into which it is to be driven, so as to bite or cling closely to the timbers; and a succession of powerful blows is requisite to urge it forward. The trenail is a little longer than the depth of the hole, and the superfluous end is taken off with a saw when the driving is finished. It is then tightened in the hole by small wedges driven in at the end.

The planking and trenailing having brought the surface of the hull to a tolerably even state, which is further assisted by a little trimming or 'dubbing' with the adze, a process follows which is indispensable to the exclusion of water from the vessel, viz. that of *caulking*. The planks cannot be brought so close together as to make the joining impenetrable to water, and the joint is therefore filled up with oakum. We explained in the last Supplement the manner in which threads of oakum are twisted by boys out of refuse rope, and alluded to the mode in which they are employed. A kind of chisel, called a caulking-iron, is employed to drive the threads of oakum into the seams. The oakum is not placed merely at the outer edges of the crevices, but is driven in to a depth equal to the whole thickness of the plank. Sometimes the edges of the planks are chiselled away a little, in order to afford room for the entrance of the oakum; and in all cases the caulkers manage the seams in such a manner as to fill them up with a dense and compact layer of oakum, which not only answers the purpose of making the

vessel tight, but also helps to consolidate and strengthen the whole ship in a very considerable degree, by making the edges of the planks bear hard against each other, so that one part cannot move or work independent of another. At the time when this caulking of the seams is going on, the planks themselves are examined, and any shakes or rents or fissures, however small, are well filled with oakum. This process being finally completed, all the caulked seams are coated, or, as it is termed, 'payed,' with hot melted pitch and rosin, by which the hempen fibres of oakum are preserved from the action of the sea-water. The *sheathing* is an exterior coating afterwards put on the bottom of the vessel; but this is a stage in the proceedings at which we have not yet arrived.

The operations withinside the vessel are, as may be supposed, much more varied than those on the outside, but they partake more and more of the nature of carpentry as the construction of the vessel advances. After the various pieces are adjusted which form the main support of the different parts of the vessel, the hull is divided into compartments accordant with the purposes for which the vessel is intended. The decks, port-holes, magazines, and berths for several hundred men in a man-of-war, and the cabins, the passenger accommodation, and luggage-room of a merchant ship, of course require different arrangements of the interior. Supposing these matters to have been completed, we will next proceed to the important affair of *launching*, by which the vessel is borne on to the liquid element which is afterwards to form her home. Those persons who have never seen a ship launched, and who are but little acquainted with these matters, may feel it desirable to know in what stage of the building process the launching is effected. We may here mention, then, that the hull is launched before it has been sheathed or coated with copper, and also before it is fitted with masts, yards, bowsprit, rudder, sails, or ropes. There are various reasons why these several parts are more conveniently fitted after than before the launching; the height of the vessel from the ground when on the building-slip—the angle at which it slopes towards the water—the difficulty of getting into the vessel, &c., are some of these reasons; and with regard to the sheathing, it is deemed better to be postponed until the soundness of the naked planking has been tested by immersion in the water.

We explained in the former article, that the ship is built on blocks, laid in regular succession along the building-slip, and so adjusted that the keel, which rests immediately on their upper surfaces, shall have

an inclination of about five-eighths of an inch to the foot towards the river. These blocks form the central support beneath the vessel, during the whole progress of building; and the vessel is further supported at the sides by shores, or poles, raised at various angles from the ground. As the time of launching approaches, preparations are made for removing all these lateral supports, for lifting the keel completely from the blocks, and for constructing two temporary "slippery paths" down which the vessel may slide into the river. The whole of these operations are very curious, and require great nicety and care to ensure success. Along the building-slip, on each side of the keel, and distant from it about one-sixth of the vessel's breadth, is laid an inclined platform, formed of many pieces of wood, and presenting a flat upper surface inclining downwards towards the river at an angle of about seven-eighths of an inch to the foot, and consequently more sloping than the position of the keel. The inclined plane thus formed is called the 'sliding-plank;' and it has a raised edge, or ledge, called the 'side-way,' or 'ribband,' projecting four or five inches upwards from its outer edge. The sliding-plank is placed upon supporting blocks, so as to be elevated some feet from the ground. A long timber called a 'bilge-way,' with a smooth under-surface, is laid upon this sliding-plank; and upon this timber, as a base, is erected a frame-work, reaching up to the hull of the ship. This frame-work, which is called the 'cradle,' is formed partly of solid wood-work, filling up the whole space between the bilge-way and the hull, and partly of short poles called 'proppets,' which are erected nearly vertically, and abut against a plank fastened temporarily to the bottom of the ship. These operations are carried on on both sides of the keel, and at a few feet distant from it; and the vessel may in this state be almost said to have three keels, the real one midway between two temporary ones. At a certain stage in the building-up of these pieces, a layer of tallow, soap, and oil is placed between the sliding-plank and the bilge-way, to diminish the friction during the sliding of the latter.

But it is not sufficient that these two temporary false keels reach up to the hull: the hull must actually bear with its whole pressure upon them, so that the blocks beneath the real keel may be relieved from the enormous weight of the vessel. To effect this, a great number of wedges are driven in just above the bilge-way, by the action of which the vessel is in some degree lifted off the blocks, and made to rest on the bilge-ways. This operation is one of the most singular which a ship-yard presents. Very frequently a hundred men are driving the wedges at once; half of them being ranged on one side of the vessel and half on the other. Each man is provided with a heavy hammer, and at a given signal all strike together, whereby a hundred wedges are driven at the same instant. The effect produced by the wedge is at all times one of a remarkable and powerful kind; and when the exertions of so many men are in this manner simultaneously applied, the effect is irresistible: the huge ship, though not actually elevated above the central blocks, is so far moved as to transfer her pressure from them to the bilge-ways and sliding-planks. If the shores by which the sides of the ship are supported were now knocked away, the vessel would be likely to slide down into the river, the bilge-ways gliding over the slippery surfaces of the sliding-planks. But to prevent this from occurring before the proper time, a short piece of wood called a 'dog-shore' is fitted to the upper end of each bilge-way, in such a manner as to prevent the bilge-way from beginning to slide so long as the dog-shore remains there.

A few other arrangements being made, the ship is ready for launching. The dog-shores, and the hammers with which they are to be knocked away, are generally painted blue, and now become conspicuous objects, for a visitor looks at them as the apparently slight means whereby the vessel is to be urged into the water. A screw is fixed against this end of the keel, to assist in urging the ship forward, if such a course be necessary, and some of the blocks under the keel are cut away, to make the vessel rest more entirely on the bilge-ways. At a given signal two men, one on each side, knock away the dog-shores; the vessel glides slowly downwards into the water; a flask of wine is thrown at the head; she is christened with the name selected for her; and when she touches the water all give her a hearty greeting. This is an exhilarating sight, and has formed the subject for many a picture; which must, however, necessarily be defective, for a picture cannot represent motion. Poets, too, have not failed to celebrate this gliding of a ship to its watery dwelling. If we transfer the scene from Plymouth harbour to the river Thames, the following lines by Carrington would not be inapplicable to our present subject:—

"At last,
By genius nobly form'd, the finish'd ship
Is ready for th' impressive launch. The day
Arrives, the Atlantic tide is swelling high
To place her on its bosom. O'er her decks
The streamers wave all-gallantly, around
Enlivening music floats, while myriads crowd
Where the bold vessel on her rapid plane
Sits proudly. Hark! the intrepid artizans
Remove her last supports;—a breathless pause
Holds the vast multitude;—a moment she
Remains upon her slope,—then starts,—and now
Rushing sublimely to the flashing deep,
Amid the shouts of thousands she descends;
Then rises, buoyantly, a graceful pile,
To float supinely on the blue Hamoaze."

Having launched our ship, we will next proceed to speak of the masts with which it is to be furnished. Whether the masts are placed in the vessel immediately after she is launched, or whether some other operations are previously performed, depends on many different circumstances; but in either case, the masts have been prepared during the time that the ship has been on the stocks, the workmen employed on the one being a totally different set from those engaged on the other, and the operations being carried on in a different part of the yard. Masts, as is well known, serve as supports to the sails, and are themselves supported by ropes and tackle. The number varies in different kinds of ships; for instance, a ship properly so called is provided with three masts; a brig and a schooner are each provided with two; while one mast forms the complement for a sloop, a cutter, or a smack. But it is necessary here to remark, that a mast is not, except in small vessels, a straight piece of timber put up in one single length; it is generally formed of three stages or tiers rising one above another, each of which receives a distinctive name. Let us take for example a 74-gun ship of war. Here are three masts, the foremast, the mainmast, and the mizen-mast; and each one of these three is formed of three subordinate masts, rising one above another, of which the lowest is termed the lower mast, the next in height the top-mast, and the third the topgallant-mast. The length of the lowest is rather more than that of the other two put together; and the united length of the whole is, in the case of the mainmast, above two hundred feet. In a merchant vessel, say of a thousand tons burden, the arrangement is just the same in principle, but the dimensions smaller, the nine subordinate masts varying from about twenty to ninety feet in length, the shortest being the mizen topgallant-mast, and the longest the lower mainmast.

The masts for such vessels as the Agincourt and Southampton East Indiamen vary from about ten to twenty-eight or thirty inches in diameter; and as the latter dimensions are too great to allow the whole to be made from one tree, the mast is built up of several pieces, laid side by side in various ways, and bearing the technical names of spindles, side-trees, front-fishes, side-fishes, cheeks, cant-pieces, fillings, heel-pieces, and others equally unintelligible to general readers. The principal part of each mast, or the whole mast, if the diameter be small, is made of Canadian fir, a tree which presents a remarkably straight and uniform trunk.

The mast-making shop, at the yard which is the object of our visit, is a very large roofed building, above a hundred feet in length by seventy in width. It is situated close to the mast-pond in connection with the wet-dock, so that the masts can be floated in or out of the yard with great facility. The mast-makers have some tools peculiar to themselves; but the main operations bear some resemblance to those by which the timbers of a ship are fashioned. The various pieces of which a mast is built up are sawn to their proper dimensions, and fitted together by various kinds of joints, called coaking, dowelling, &c., and of which the common tenon and mortice will furnish some idea. Various cutting instruments are employed to give the rounded or convex form to the mast, when the pieces are put together; and pieces of wood are attached to its surface, to answer several purposes, when the mast is put in its place in the ship. The extent to which this building-up of a mast goes may be judged from the fact that the lower mainmast alone of an East Indiaman weighs upwards of six tons; and when lying along the floor of the mast-shop, its length of ninety feet and thickness of two and a half impress one with no mean idea of its bulk.

The various pieces of which a large mast is formed would not be permanently retained in their proper places, were there not some external band or tie employed. The band used for this purpose consists of a series of iron hoops, ranged at intervals of four or five feet apart along the mast. These hoops are formed of iron bands about three inches in width and three-eighths of an inch in thickness; and after being welded as nearly as may be to the girth of the mast, they are fixed on it. Each hoop—of which the lower mainmast contains about twenty, and the others a proportionate number—is in the first place heated, not to such a degree as would scorch the wood on which it is laid, but so far as to give a slight expansion to its dimensions. A small brick-built kiln is situated near the mast-shop, and in this kiln a fire is made, on which the iron hoop is laid to be heated. When the heating is effected, the hoop is taken up by means of a kind of tongs, carried to the mast-shop, put over the small end of the mast (for every mast is of smaller dimensions at one end than the other), and pushed on as far as its diameter will permit. A party of fourteen men then join their exertions to drive the hoop on as tightly as possible. Six of them grasp a long iron bar called a 'poker,' and stand in an oblique line on one side of the mast; six others hold a similar bar on the other side of the mast; and the remaining two are provided with heavy hammers. The men, thus placed, then strike the hoop with the two pokers, the end of each poker being made to strike against the edge of the hoop, and all the twelve men urging the two pokers simultaneously, by which very powerful blows are given. At the call of 'hands up,' the men direct their blows to the edge of the upper part of the hoop; while 'hands down' is a direction to them to make the blows lower down. The two men with the hammers meanwhile deal powerful blows on the surface or face of the hoop. As the hoop is driven onwards to a thicker part of the mast, it necessarily binds the wood more tightly, and this is still further effected by the contraction of the hoop as the iron becomes cold. The ultimate effect is that the hoops give an extraordinary degree of strength to the mast. Our frontispiece represents this process of 'hooping a mast.'

The *bowsprit* and the *yards* of a vessel are made by the mast-makers, and may indeed be considered as masts, so far as the mode of making is concerned. The bowsprit is a large mast which projects obliquely over the stem, to carry sail forward, in order to govern the fore part of a ship, and to counteract the force of the after-sails; it also serves to hold the stays or ropes by which the foremast is kept in its position. It generally rises at an angle of about thirty-six degrees. It very nearly equals in diameter and is about two-thirds of the length of the lower mainmast; being, in an East Indiaman, nearly sixty feet in length, and two and a half in diameter at the larger end. The *yards* are long pieces of timber suspended upon the masts, for the purpose of extending the sails; some being suspended across the masts at right angles, and called square yards; others suspended obliquely, and termed lateen yards. The number of these yards in a large ship is about twenty, and the dimensions of some of them are very considerable. The main yard of a first rate man-of-war is above a hundred feet in length and two feet in diameter; while the other remaining yards have various lengths down to about twenty feet, and various diameters down to three or four inches.

While hearing of these very large and ponderous masts, yards, &c., the reader may naturally inquire how they are conveyed to the ship, and lifted in their places. On this point we will now offer a brief explanation. The great difficulty is to get in the three lower masts; for the upper ones are afterwards drawn up by means of tackle with comparative ease. The lower masts are fitted in three different ways, viz. by *sheers*, by a *sheer-hulk*, or by a *masting-house*.

The *sheers* used in masting vessels are two large poles, masts, or spars, erected on the vessel whose masts are to be fixed; the lower ends resting on thick planks laid along the sides of the deck, and the upper ends crossing each other, where they are securely lashed. The point where the two spars cross is exactly over the hole where the mast is to be dropped through the deck; and the spars are retained in this position by strong ropes attached to different parts of the ship. The mast, being floated to the side of the ship, is elevated entirely above deck by means of tackle connected with the sheers; and when it is brought with the lower end immediately over the hole in the deck, it is gently lowered into its place, passing down through the entire height of the vessel, and resting on the step or block fixed to the keelson. When one of the three masts is fixed in this way, the sheers are moved to the spot where the second is to be placed, and afterwards to the third. This is the general mode of masting merchant ships.

The *sheer-hulk* is an old man-of-war cut down to the lower deck, and fitted with an apparatus of sheers, tackle, &c. for masting the ships of the royal navy. There is a mast, a hundred and twenty feet in length, fixed in the hulk, and acting as a support to three or four stout spars or sheers which project obliquely from the side of the vessel. The tops of these sheers are at such a height, and project to such a distance from the side of the hulk, that the vessel which is to be masted can come beneath them, and be fitted with her lower masts, which are hoisted up to the requisite height by the sheers, and then lowered into the vessel. This is the general mode of masting ships of war.

The *masting-house* is a building erected expressly for the operation of masting ships. We are not aware whether there are others of the kind in this country;

but the one at Blackwall, formerly spoken of as once belonging to Mr. Perry, and as being now in the possession of the East India-Dock Company, is the place at which the ships from the Blackwall yard are masted. It is a square wooden building, erected on the western quay of the outward-bound dock, and having, at the top, a platform overhanging the water to the distance of several feet. The ship to be masted is floated into this dock from the Thames, and brought immediately beneath the overhanging platform. The masts are likewise floated in; and, after being hoisted up one by one by means of tackle connected with the platform, are lowered into their proper places in the ship.

Having thus spoken of the masting of a vessel (by which is usually understood the lower masts only), we will follow it back to the building-yard. We have before explained the difference between a building-slip and a dry-dock, and the manner in which a ship is brought into the latter. We will suppose it therefore to have been dry-docked, and to be ready for the process of *sheathing*, which is frequently done about this stage of the proceedings. The planks with which the timbers of a ship are covered, although the seams may be caulked with oakum and pitched, are not in a condition to be exposed to the sea without serious injury, and a casing or sheathing is therefore applied. Deal or fir plank, sheet lead, brown paper coated with tar, and sheet copper, are the substances which have been employed for this purpose; and experience has shown the last to be the best. Formerly so much grass, ooze, shells, sea-weed, &c. accumulated on and adhered to the bottom of a ship during a voyage, that the speed was impaired; and a process of breaming or graving was frequently required when she was in dock. This breaming consisted in melting the pitchy coating with which the bottom was covered, by holding kindled furze, faggots, or reeds under it, and thus loosening the matters which adhered to it, and which were subsequently scraped and brushed off. With the hope of rendering this process less frequently necessary, a sheathing of copper was proposed about eighty years ago; and the result was so satisfactory, that in 1783 the government ordered all ships belonging to the royal navy to be copper-bottomed. The practice spread from thence to the mercantile marine, and is now very generally followed.

The sheets of copper, or of an alloy of copper and zinc, for sheathing, are about four feet long by fourteen inches wide; the thickness being such that one square foot weighs from sixteen to thirty-two ounces, generally from twenty to twenty-eight. The copper is sometimes laid on the bare planking, but in other instances there is an interposed layer of paper, of felt, or of sheathing-board. The two latter are nailed on in their usual state; but if paper be employed, the sheets are first dipped in a mixture of melted tar and pitch, left to dry, and then nailed on. But whether these interposed layers are used or not, the copper sheets are put on in a pretty uniform plan. The sheets are pierced with holes, not only all round the edges, but at intervals of three or four inches over the whole surface. Each sheet laps about one inch over the adjoining sheet, and is fastened to the ship by means of flat-headed nails, made of the same metal as the sheets. Great regularity is observed in the arrangement of the sheets, so that a certain symmetry of appearance, as well as a durability, is attained.

The number of sheets of copper required for a large ship is very considerable. Nearly eight thousand square feet are required for each of the two vessels, the Agincourt and the Southampton, before alluded to. After two voyages to the East Indies, the coppering requires to be renewed; and the old copper is found to have lost three or four ounces of its weight in the square foot, by the action of sea-water, friction, and other causes. For re-coppering a vessel, the ship is docked, and stages or platforms built round her hull, on which the workmen may stand. With instruments adapted to the purpose, the men then strip the old copper from the ship's bottom; and it is sent away to the copper-works to be again melted up into a useful form. The surface of the planking being brought tolerably smooth, and prepared in one or other of the ways alluded to above, the nailing on of the sheets of copper proceeds in the same way as for a new vessel. In a ship-yard such as that at Blackwall, where many hands are employed, and the general arrangements are on a complete scale, a vessel is frequently sent out of dock thoroughly new-coppered within two days of the time when she entered it.

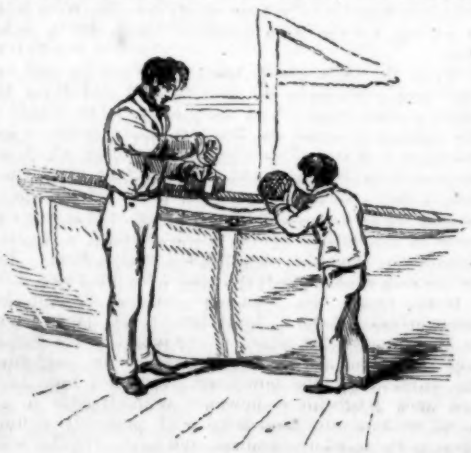
We must now say a little respecting the sails and rigging of a ship. There is a superintendant either engaged in or in some measure connected with ship-yards, called the 'ship's husband,' whose office is of much importance. The term is a remarkable one, but it is in character with the general tone in which a ship is regarded by those about her. A ship in the eyes of a seaman is a lady; there is probably no instance in which an inanimate object is regarded with more admiration—nay, even affection—than a gallant and well-fitted ship is by her crew; and a landsman may perhaps be permitted to say that there are few more worthy of it. The 'ship's husband' is one who is well acquainted not only with the arrangement and forms of the sails and rigging, but with the general details of seamanship, and with the services which are required from every sail, yard, and rope; and his office is to see that the ship—his bride—is decked out with all the trappings necessary for her personal appearance and for her future life on the waters. Although the two facts, that sails are intended for the propulsion of a ship by the wind, and that the rigging is intended chiefly for the management of these sails, may appear tolerably simple, yet the judicious arrangement of the several parts is a matter of great intricacy, and requires long study and experience.

The rigging of a ship, which is generally understood to imply the whole assemblage of ropes with which she is fitted, is of two kinds, one termed the *standing* and the other the *running* rigging. The former term is applied to all the shrouds, stays, back-stays, and other ropes which are employed to maintain the masts and bowsprit in their proper position, and which remain pretty nearly in a constant state whether the ship is in full sail or all the sails are furled; the latter term is applied to various ropes called braces, sheets, tacks, haliards, buntlines, &c., which are attached to different parts of the masts, yards, sails, and shrouds, and are employed principally in furling and unfurling the sails for the purposes of navigation. The whole of this rigging is made of hempen fibres, more or less saturated with tar. Those pieces of cordage which are devoted to the management of the anchors are termed *cables;* those which are employed in the general operations of rigging, and are more than an inch in circumference, are termed *ropes;* while cordage of smaller dimensions than this is generally called *lines*. But this classification is not sufficient for the purposes of the seaman; every cable, rope, and line has a distinctive name belonging to it, according to the place where or the purpose for which it is applied. The breast-rope, the davit-rope, the quest-rope, the heel-rope, the parral-rope, the bow-lines, clue-lines, bunt-lines, tow-lines, leech-lines—however unintelligible to general readers—are associated with perfectly definite ideas in the mind of a seaman, and have a regular scale of dimensions.

There are, we believe, no private ship-building

firms which make their own cordage. The government yards have ropewalks for this purpose; but in other cases the cordage is supplied by rope-makers, who confine their operations solely to this department. In our 495th number will be found a brief account of the process of rope-making; and we may therefore merely state here that the cordage is supplied to the riggers, in coils and bundles of various sizes, comprising the necessary lengths of all the different kinds of rope and line. The business of a ship's-rigger is distinct from that of a ship-builder; and the operations may or may not be carried on in a ship-building yard, according to the facilities which the yard presents and to other circumstances.

But wherever the rigging may be carried on, the operations are always nearly alike. The rigging-house is a place provided with tackle for stretching the ropes, and with the necessary instruments for attaching the blocks, rings, &c. required for fixing the ropes to the ship, and for managing the sails. The blocks here alluded to are a kind of wheel working in a wooden case, round the circumference of which a rope is passed to act as a pulley. They are sometimes made in the mast-making shop, and at other times by persons who follow that line of business only. The outer case or 'shell' of a block is made of elm or ash, and after being rounded somewhat to an oval form, various perforations are made through it. One of these is for the reception of a pin or spindle, made of lignum-vitæ, or some other hard wood, or of iron; and others are for the reception of the wheels or 'sheaves,' which vary from one to eight in number in each block, and which are made of lignum-vitæ. The adjustment of the ropes to these blocks, to iron rings and hooks, and to each other, devolves upon the rigger, who is provided with instruments for cutting, stretching, bending, and tyeing the ropes in their proper places. The cordage employed for a large East Indiaman weighs several tons, and some of the ropes are four inches in diameter: the bending and fixing of such ropes as these, therefore, require powerful implements. Among the operations which much of the cordage undergoes before it is taken to the ship, is that of 'serving.' This consists in binding a smaller rope very tightly round it, in order to preserve it both from rotting and from any friction to which it may be exposed. The substance thus bound round the rope is not necessarily a made-rope of smaller diameter, but is sometimes formed of old canvas, mat, plat, hide, or spun-yarn, according to circumstances. All these substances receive the common name of 'service;' and the mode of proceeding may be understood by a description of the process of 'serving' a rope with spun-yarn. The yarn might be simply twisted by hand round the rope, but the necessary tightness and compactness would not be thus attained; and a mallet is used instead. The rope being stretched out horizontally, a man provided with a mallet, and a boy holding a ball of spun-yarn, stand opposite to each other at about two feet distance. The mallet, which has a concave groove on the side opposite to the handle, is laid on the rope, handle uppermost. Two or three turns of the spun-yarn are passed tightly round the rope, and round the body of the mallet; and while the boy passes the ball of yarn continually round the rope, the man, at the same time, and in the same direction, winds on the yarn by means of the mallet, whose handle, acting as a lever, strains every turn about the rope as firmly as possible. The yarn then appears like a screw whose threads pass almost transversely round the rope. The annexed cut shows the position occupied by the man and boy while 'serving' a rope.



While describing the process of masting a vessel, we stated that it is only the lower masts and the bowsprit which are fitted by the sheers, the sheer-hulk, or the masting-house. The upper masts are not drawn up till the stage in the proceedings at which we are now arrived. The lower masts require to be secured by shrouds, &c. before the others are adjusted to them, so that the raising of the latter takes place after the rigging of the ship has been commenced. We have stated that the topmast surmounts the lower mast, and that the topgallant-mast surmounts both; but the masts are not actually joined end to end, in the usual sense of this term. A few feet below the upper end of the lower mast, a kind of platform is erected, on which the topmast rests, a little in front of the lower mast, so that the two do not actually touch in any part. This platform is called the 'top,' and is supported by various timbers termed cross-trees and tressel-trees. The topmast is drawn up to its place by means of tackle, and fixed securely to the platform, as also to a piece of timber projecting forwards from the extreme top of the lower mast. The platform serves not only as a support to the topmast, but also as a place of attachment for the shrouds by which it is upheld. When the topmast has been raised and properly secured in its place, the topgallant-mast is similarly raised, and adjusted to the upper end of the latter; and in some of the ships of war there is still a fourth mast, of very slender dimensions, called the topgallant-royal-mast, raised highest of all; but it is generally a mere prolongation of the topgallant-mast above the rigging, instead of being a separate and distinct mast. The bowsprit is, like the mast, provided with a kind of topmast or top-bowsprit, by which its effective length is increased. In this manner the vessel is gradually provided with all her masts and yards; the shrouds, stays, and other standing rigging being adjusted to their places at the same time. The yards too, or the ponderous horizontal spars by which the sails are held, are introduced into the vessel one by one, and attached to the masts to which they belong. Whoever has seen a representation of a ship with her sails furled, must have remarked the vast number of ropes and blocks which connect the various parts of the masts and yards together, and which quite baffle the eye in an attempt to single them out one from another. All these ropes have certain definite offices to perform, and are placed in their respective positions by the rigger.

Meanwhile, the sail-makers have been at work, preparing their important share of the ship's fittings. We stated, while giving a general description of the ship-yard which is the object of these two papers, that

the sail-loft is situated near the mould-loft. It is an oblong apartment, sixty or seventy feet in length, and provided with tackle for stretching and drawing out the ropes which are sewn to the edges of the sails. During the principal parts of the operations, the sail-makers are seated on stools, of which several are placed in different parts of the loft, each provided with little receptacles for the tools which he requires.

The canvas used in making sails is a very stout material, woven, either in England or Scotland, from hemp brought from Russia, and purchased in the form of rolls called 'bolts,' each bolt containing about forty yards of canvas, twenty-four inches in width. There are six or seven different qualities of canvas, according to the size and position of the sail to be made; and each quality has a particular number attached to it, and must have a certain weight per square foot; thus, in the royal navy, a bolt of No. 1 canvas, containing thirty-eight yards, must weigh forty-four pounds, whereas No. 7 weighs only about half as much; the intermediate numbers having intermediate weights. The canvas, though woven of stout yarn, is very regular and uniform in its appearance, and of a tolerably white tint.

The first operation is, to cut up a sufficient quantity of canvas to make a sail; and as the width of the canvas, whatever be its quality, is only two feet, a great number of breadths become necessary. The mainsail of an East-Indiaman contains nearly seven hundred yards of canvas; while the whole suit of sails requires as much as nine thousand yards. Some of the sails are nearly rectangular, some triangular, some of the edges are straight, some hollowed, and the foreman has to pay especial attention to these circumstances in arranging the breadths of canvas. To cut a piece of canvas directly across, the weft or cross-thread is taken as a guide; while an oblique section is marked out by a certain deviation from the direction of the weft. The canvas is not cut by shears or scissors; but a fold being made in the required direction, previously marked with chalk or pencil, two men hold the two ends of the fold, and one of them rips up the canvas with a sharp knife.

The canvas being cut, the sail-makers then proceed to work it up. Their labour consists not only in seaming up the numerous breadths, so as to give the requisite dimensions to the sail, but also in sewing on rope, called 'bolt-rope,' round every edge of every sail: were the sail not strengthened in this manner, it would neither bear the strain of the wind, nor furnish fastenings for the ropes by which it is worked. The seaming and sewing are effected with large three-sided needles, of seven or eight different kinds, which are threaded with sewing-twine made for the purpose, and having from two to four hundred fathoms to the pound weight. The skeins of twine, previous to being used, are dipped into a trough containing melted tar, grease, and oil, and are twisted round in such a manner as to force the composition completely through the twine, and to expel the superfluous portion. The twine, when dry, is wound into balls, or on reels, ready for the workman.

The sail-maker, seated on his low stool, holds the canvas before him in a convenient position for working. On his thumb he wears a thumb-stall, consisting of an iron, horn, or leathern ferrule, against which the thread passes, enabling him to tighten the stitches without hurting his thumb. He has also a little contrivance called a 'palm,' consisting of a flat round piece of iron, chequered or grooved on its surface, and intended to act as a thimble: it is sewn to a piece of leather, which enables it to be conveniently attached to the palm of the right hand. The breadths of canvas are joined by stitching or 'seaming,' the stitches having a degree of closeness well agreed upon between master and man, and such as to include rather above a hundred stitches in a yard of length. The seam or overlapping is from an inch to an inch and a half in

width. Besides the stitching of the seams, various pieces of canvas called linings, tablings, and bands are stitched on the sail in different directions, for the sake of strengthening it at those parts which are most liable to strain. There are also many small holes to be made in some of the sails, for the reception of short pieces of cordage necessary in reefing the sail.

The bolt-rope which is fastened to the edge of the sails is carefully covered before it is used, to preserve it from rotting: it is first 'parcelled,' that is, encircled with narrow pieces of old canvas; then well tarred; and afterwards 'served' or bound round with a close coil of spun-yarn. The ropes are then sewn to the edges of the sail in a very careful manner; arrangements being at the same time made for the formation of numerous loops, eyes, and other mechanism necessary for the subsequent guidance of the sail. Different parts of the bolt-rope receive different names according to their position: that which binds the bottom edge is the foot-rope; at the top, the head-rope; at the sides, the leech-rope.

Thus the operation of the sail-maker proceeds, until the whole suit of sails, generally about forty in number, for a ship are made. So well arranged are the plans by which the canvas is cut for the sails, that not more than three or four yards are actually wasted in cutting up the nine thousand yards for a large ship.

When the sails are finished, they are adjusted to their proper places in the ship by means of the ropes which govern them. The anchors (a brief account of the making of which was given in our Nos. 537, 538), the colours, the interior fittings and furniture, and a large variety of matters which we cannot even enumerate, being also completed—the lady, in fact, being decked out in her complete attire—she is sent out of dock to the bosom of the waters, where, to use the language of Canning, she lies "majestically reposing on her own shadow," till the hour of sailing arrives.

If the reader has expected to become a veritable ship-builder by the perusal of this sketch, he will doubtless be disappointed; but if it merely conveys to him some idea of the vastness, the variety, and the ingenuity of the operations involved in the construction of a ship, free from the embarrassment of the technical details necessary in a scientific treatise, the proposed object will have been attained.